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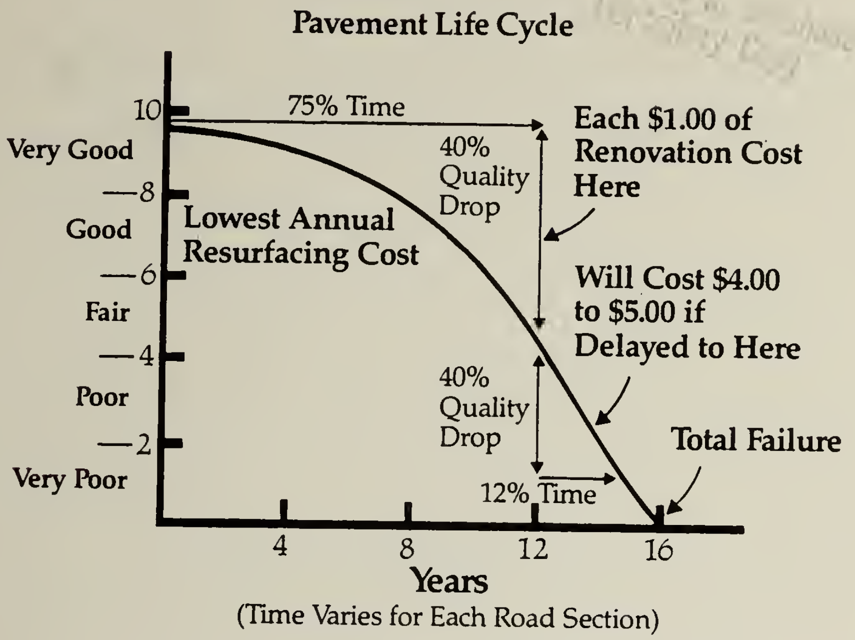

Funding the Rehabilitation and Reconstruction of Locally Maintained Roads in the MAPC Region

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Planning Council
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FUNDING THE REHABILITATION AND RECONSTRUCTION OF LOCALLY-MAINTAINED ROADS IN THE MAPC REGION

September 1987

Cover illustration courtesy of: American Public Works Association,
Pavement (Maintenance) Management Systems

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FUNDING THE REHABILITATION AND RECONSTRUCTION OF LOCALLY-MAINTAINED ROADS IN THE MAPC REGION

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EXECUTIVE SUMMARY

In 1980, Massachusetts enacted legislation limiting local property taxation. As a result, local governments have had to be very selective in spending available revenue. Unfortunately, many have deferred road maintenance to support other urgent programs, a response which eventually leads to increased costs and decreased user comfort and convenience. As MAPC communities develop pavement management programs to reverse this trend, it appears that there may already be insufficient funds regionwide to maintain local roads.

However, it may be that the remedial programs required to upgrade local roads would be too costly for many local governments to support. The purpose of this study is to define ongoing maintenance and backlogged needs, assess the magnitude of the problem, and estimate the funding needs for the region's locally-maintained roads so that possible solutions may be explored.

The first part of the study reviews road improvement expenditures and funding trends in the region for the past nine years to provide a perspective on the current maintenance backlog. Analysis of data from the Massachusetts Department of Revenue shows that, in constant 1986 dollars, yearly local expenditures for the repair or reconstruction of the region's 9,520 miles of locally-maintained streets decreased more than 50 percent between 1978 and 1985, falling from about $56 million to $26 million. Meanwhile, state funding for local road improvements through Chapter 90 appropriations remained relatively unchanged at approximately $20 million per year according to information provided MDPW.

The second part of the study explains a simple model that simulates the contest between pavement deterioration and roadway maintenance. The model projects both future street conditions and financial needs, based on typical pavement deterioration rates, sampled road conditions, average maintenance and repair costs, and current expenditure levels. Data for the model is based on information from local pavement management reports and surveys of local public works officials as well as technical manuals.

The road maintenance forecasts indicate that current funding for local roads in the MAPC region is inadequate. In fact, the present level of $26 million annually is not sufficient to maintain the streets in their present condition. If that funding level is sustained for the next 10 years, over 67 percent, or 6,380 miles, of local roadways will be in poor condition, compared to 19 percent, or 1,820 miles, in that condition now.

However, if the region could sustain an annual spending level of approximately $143 million over the next 10 years, all of the highway network could be in excellent condition. Furthermore, the cost of maintaining these roads in excellent condition would be only $12 million per year - less than half of the $26 million which cannot maintain the existing roads. However, it will take a few years to invest enough to improve overall conditions, simply because of the current conditions of the streets. This is a direct effect of previous deferred maintenance.

Finally, the report concludes with a set of recommendations based on these findings. They are:

- Encouragement of long-term planning by communities for roadway improvements;
- Development of alternative maintenance strategies to make the most effective use of available resources;
- Increased communication and coordination between communities to exchange pavement management information and experiences;
- Further research in several areas, including modelling the effects of additional factors such as road classification, pavement age, and past maintenance procedures, and the tradeoffs between different maintenance options; and
- A feasibility study of possible sources of additional funding for the maintenance of local roads.

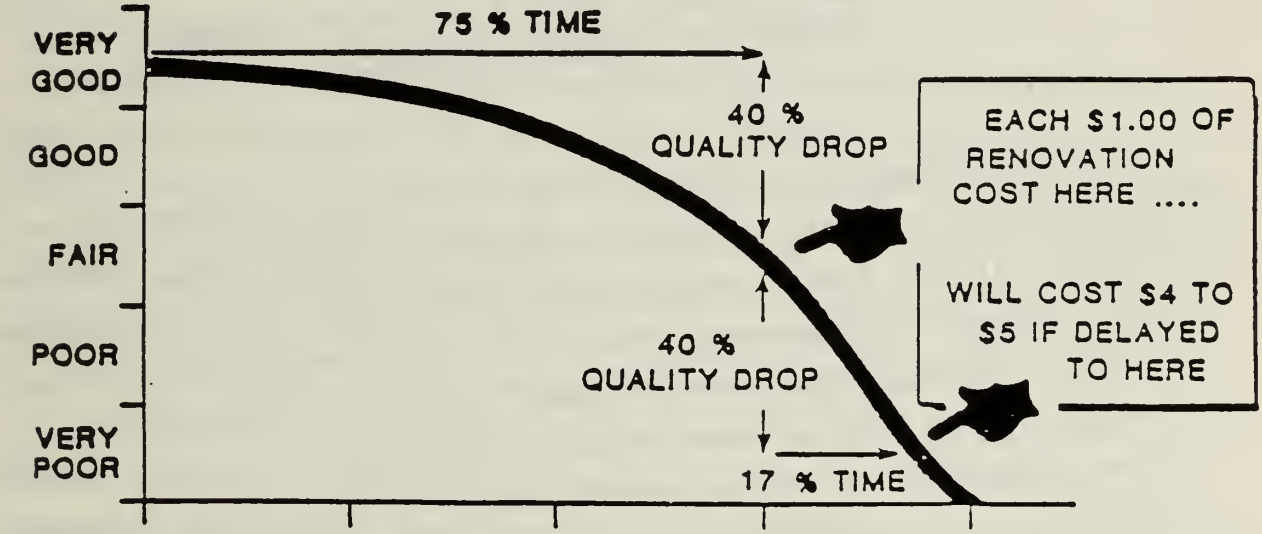
INTRODUCTION

Background

As the surface of a paved road ages, the pavement deteriorates - first slowly and then rapidly as shown in Figure 1. When the surface is cracked, sealing or crack filling may be sufficient to return it to its original condition. However, inattention to slight deterioration results in further roadway damage, which goes deeper into the roadway and requires an overlay, or eventually, reconstruction of the surface and base. Thus, overdue maintenance can cost four or five times as much as timely maintenance.

FIGURE 1

NORMAL PAVEMENT DETERIORATION

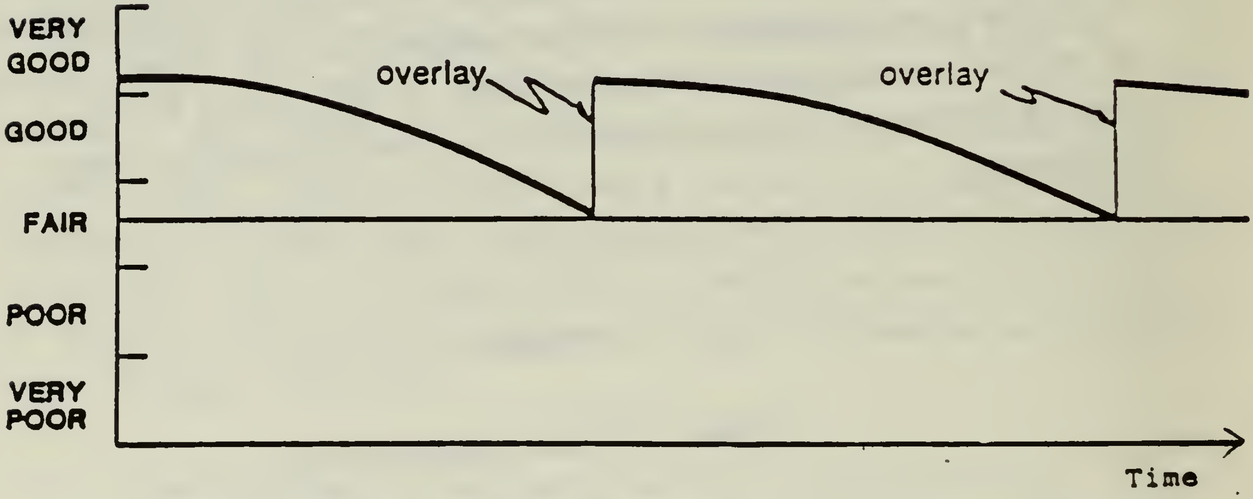


Source: Federal Highway Administration, Road Surface Management for Local Governments

In theory it is possible to maintain a road in very good condition, economically, as shown in Figure 2.

FIGURE 2

TIMELY PAVEMENT MANAGEMENT



Source: American Public Works Association, Pavement (Maintenance) Management Systems

In 1980, Proposition 2 1/2 put a cap on local tax revenues in Massachusetts. As a result, local governments have been very selective in spending available funds. Unfortunately, many communities have deferred road maintenance expenditures in favor of other urgent projects and programs. Although these cutbacks appear relatively harmless when compared with cutting police or school system budgets, a town that defers roadway maintenance is setting course toward more costly road improvement expenditures in the future.

Last year the Metropolitan Area Planning Council (MAPC) began to respond to local governments' need for pavement management, justifying funding proposals and setting priorities for overdue road repair projects and preventative maintenance projects. Drawing on a committee of experts from academia, consulting, state and local government, and from literature on pavement management, MAPC developed a manual for local pavement management. The publication, Pavement Management: A Manual for Communities explains a simple planning method that requires few resources, and is useful to superintendents of small or large highway systems.

About one-half of the 101 MAPC communities participated in follow-up workshops that were held to explain the manual's use. Many of these communities now have pavement management programs. Six communities, Ashland, Belmont, Burlington, Holliston, Reading, and Wenham, have completed comprehensive inventories of all road conditions and developed programs for long-term maintenance. Other communities have effectively demonstrated the need for road maintenance funds and are beginning to achieve their goals for adequate funding. In Hopkinton, for instance, residents approved a referendum in October 1986 overriding Proposition 2 1/2 in order to fund $900,000 worth of road improvements.

Purpose

It appears, however, that the shortage of funds for the repair of locally-maintained roads may be a regional problem. Many communities, both large and small, are overwhelmed by a growing backlog of maintenance projects. Local public works and engineering officials are concerned that current roadway maintenance expenditures are inadequate and that streets and roads are deteriorating faster than they are being repaired. Increasingly, bumps, cracks, and potholes are not repaired. This translates into a much rougher ride for road users, increased driver costs (tires, accidents, insurance, alignment, etc.), and significantly increased public costs when preventative maintenance is no longer possible and roadways must be reconstructed.

It may be that the remedial programs required would be too costly for many local governments to support. The purpose of this study is to define ongoing maintenance and backlogged needs, assess the magnitude of the problem, and estimate the funding required for possible solutions.

Study Design

The study has two major components. The first part includes an inventory of the existing road network in the MAPC region, an inventory of communities' spending on past highway improvements, and an analysis of expenditures and funding trends for the past nine years. This information is used to offer some perspective on the current maintenance backlog. The second component uses a model to simulate roadway maintenance and pavement deterioration. Using expenditure levels and existing roadway conditions, the model projects both future street conditions and financial needs.

Since complete information from every city and town in the region is often unavailable, several assumptions are based on a sample of 15 communities: Ashland, Belmont, Bolton, Brookline, Burlington, Concord, Hingham, Holliston, Lincoln, Medfield, Reading, Stow, Sudbury, Waltham, and Wenham. The sample includes data from six communities that conducted local comprehensive pavement studies and from six communities included in "Local Highway Maintenance Problems and Needs in Massachusetts - Phase II" (Massachusetts Infrastructure Project, 1986) by Dr. John Collura (University of Massachusetts at Amherst). The remaining three communities were selected to make the sample an accurate representation of the region. Based on the characteristics of road mileage and maintenance expenditures per mile, this representative sample has only a slight weakness in considering high expenditure, high mileage communities. For a complete description of the representative sample, refer to Appendix A.

The City of Boston was not considered in selecting the representative sample or making regional assumptions for the model since its size, in comparison with the other communities in the metropolitan area, distorts the data from the other communities. Nevertheless, the model is applied to the entire region, including Boston, in order to estimate the region's future financial needs and road conditions.

PAST TRENDS

Before it is possible to predict financial needs for improving the region's roads, it is necessary to define the highway network and its current maintenance backlog. To offer some perspective on this backlog and how it has developed, the first part of the study examines the current street system and analyzes historical trends in maintenance expenditures and funding.

The Road Network

The MAPC region has over 10,400 miles of streets and roads according to 1984 data from the Massachusetts Department of Public Works (MDPW) (see Table 1). The Commonwealth is responsible for maintaining more than 680 miles of the network, while other authorities, such as the Metropolitan District Commission, the Massachusetts Turnpike Authority, and the Massachusetts Port Authority, maintain about 200 miles. The remaining 9,520 miles, or 91% of the region's roadways, are either fully maintained by the communities or are officially classified as unaccepted. However, although these unaccepted streets do not yet meet local standards, their maintenance is the responsibility of the cities and towns. Therefore they are included in this study. The study does not consider roads that are privately owned or maintained.

In addition, 1985 data from MDPW shows that a full 69 percent of locally-maintained roads are functionally classified for local service. These streets and roads are intended to serve abutters rather than through traffic. Another 25 percent of the local roads are collector streets which connect the local streets to the nearest major streets and highways. Slightly less than 9 percent of the region's local roads lie within the City of Boston. For complete data on the road network, see Appendix B.

TABLE 1

THE ROAD SYSTEM IN THE MAPC REGION

Administrative System

State	686 miles	(7%)
Communities	8,341 miles	(80%)
Other Authorities	199 miles	(2%)
Unaccepted	1,177 miles	(11%)
	10,403 miles	

Source: MDPW Bureau of Transportation Planning and Development, Statewide Transportation Section, 12/31/84

Functional Class of Locally-Maintained Roads

Arterial	560 miles	(6%)
Collector	2,371 miles	(25%)
Local Service	6,589 miles	(69%)
	9,520 miles	

Source: MDPW Bureau of Transportation Planning and Development, December 1985

Federal Aid / Administrative Systems Matrix

FA SYSTEM	STATE	LOCAL	OTHERS	TOTAL
Interstate	149.32	0.00	20.44	169.76
FA Primary	295.38	185.87	41.88	523.13
FA Secondary	21.86	175.90	0.20	197.96
FA Urban Systems	198.26	2,326.16	83.02	2,608.44
NonFederal Aid	23.87	6,830.55	53.76	6,908.18
TOTAL	688.69	9,518.48	200.30	10,407.47

Source: MDPW Bureau of Transportation Planning and Development, 1981 (From Transportation Facts, CTPS, 1983)

Expenditures

Expenditures to maintain that part of the system under local jurisdiction have decreased in recent years. This is shown by past expenditures for street repair and construction as reported in the "Annual City and Town Financial Reports," Schedule A, maintained by the Bureau of Accounts at the Massachusetts Department of Revenue. Additional data was taken from Boston's Infrastructure Investment Record (April 1984). Data was assembled for 1978, 1982, 1984, and 1985.

However, further research and data collection found several inconsistencies in the Annual Financial Report data. Therefore, more accurate information on communities' expenditures for road repairs and reconstruction was collected and verified through interviews and surveys of local highway officials.

All expenditures were adjusted to constant 1986 dollars, using a discount rate of 6 percent, derived from Federal Highway Administration data on road construction costs for 1978 to 1986. For complete expenditure data, see Appendix B.

However, there were difficulties deriving information from the Annual Financial Reports. First, several communities failed to submit Financial Reports in past years, especially before 1982 when submission was voluntary. To account for this missing data, the average expenditure per mile was calculated using existing data and then applied to the region's total mileage.

Second, towns generally do not distinguish between road improvements and other highway costs such as administration, lighting, sanding, and labor. To compensate for this inconsistency in reporting categories, information on six communities from Dr. John Collura's Massachusetts Infrastructure Project (1986) was used together with data for seven additional towns, which was obtained through interviews with highway superintendents. The data in Table 2 indicates that, on the average, only 27.5 percent of expenditures reported in the Financial Reports were used for surface treatments and reconstruction. A 95 percent confidence interval yields upper and lower limits of 35.1 percent and 19.8 percent respectively.

Applying the 27.5 percent factor to the Financial Report data, it was found that, in constant 1986 dollars, yearly local expenditures for the repair and reconstruction of the region's 9,520 miles of local highways decreased by over 50 percent between 1978 and 1985, falling from about $56 million in 1978 to approximately $26 million in 1985 as shown in Figure 3.

FIGURE 3

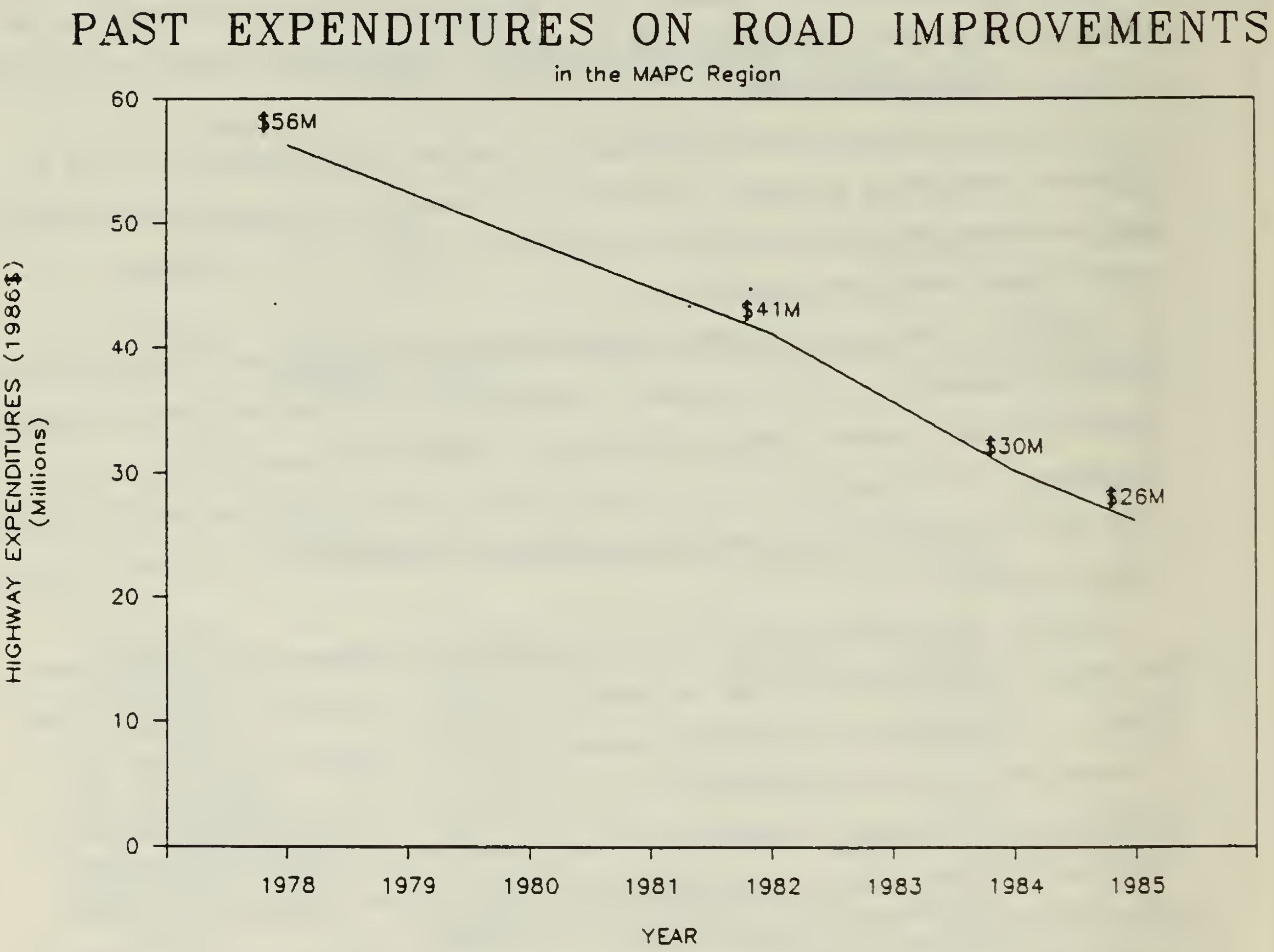


TABLE 2

COMPARISON OF TOTAL HIGHWAY EXPENDITURES AND EXPENDITURES FOR ROAD AND STREET IMPROVEMENTS ONLY

(including Chapter 90 funds)

Community	\$ Total Spent on Highway Work[1]	\$ Spent on Improvements[2]	% of Total On Improvements
Bolton *	$189,923	$41,340	21.8
Concord *	595,087	161,650	27.2
Lincoln (85) *	590,332	215,180	36.5
Stow (85) *	578,317	63,600	11.0
Sudbury *	978,101	445,200	45.5
Waltham *	810,938	106,000	13.1
Wenham **	215,346	65,932	30.6
Belmont ***	1,200,000	225,000	10.2
Brookline ***	3,880,000	477,267	12.3
Hingham ***	2,100,000	405,000	19.3
Holliston ****	867,876	360,000	41.5
Lincoln (86) ***	500,000	75,000	15.0
Medfield ***	343,000	229,000	66.8
Reading ***	780,000	238,478	30.6
Stow (86) ***	297,000	90,000	30.3
		Mean	27.5%
		Median	27.2%
		St. Dev.	15.1%

95 percent confidence interval: 19.8 < true mean < 35.1%

NOTES ON NEXT PAGE

NOTES ON TABLE 2

(continued from previous page)

1 "Highway Work" includes numerous expenditures, such as wages and salaries, snow removal, general expenses, and maintenance.

2 Figures for expenditures on improvements do not include labor.

* Total highway expenditures are from 1985 Annual Town Financial Report and include items listed under highway construction, highway improvement, highway total, and betterment total (for complete information, see Appendix B); improvement expenditures from interviews by Dr. John Collura in Massachusetts Infrastructure Project (1986).

** Wenham data is from 1984; supplied by Nancy Brown, Town Accountant

*** Data is from 1986; collected by MAPC through interviews with local DPW superintendents.

**** Holliston's total expenditures are from 1985 Annual Town Financial Report; improvement expenditures from MAPC interview with Highway Superintendent Remo R. Vito, Jr.

NOTE: ALL DOLLAR AMOUNTS ARE CONVERTED INTO 1986 DOLLARS USING AN ANNUAL INFLATION RATE OF 6 PERCENT (derived from FHWA data on road construction costs over the same time period).

Other Funding

Other than local revenues, funds used for the improvement of highways traditionally come from the federal government and the state government. However, as shown in Table 1, over 70 percent of locally-maintained roads in the region are not elgible for federal aid. Federal aid through Urban Systems grants, which are available for 25 percent of local roads, are project-specific and cannot be used for road surface repairs beyond the scope of improving safety or increasing a road's capacity.

Therefore, in addition to local revenues, the state provides the primary source of funding for general improvements to locally-maintained roads. The state finances these improvements through a state gasoline tax and the proceeds of periodic bond issues. This "state aid" is distributed through a number of programs in Massachusetts, predominantly through annual Chapter 90 allotments. The provisions of the General Laws, Chapter 90, Section 34(2)(a) provide for the apportionment of revenue to the public highway departments of the cities and towns of the Commonwealth to be used for the repair and improvement of roads other than state highways.

According to MDPW guidelines, these funds shall be used for "construction, reconstruction and improvement" on all approved public ways which qualify under the State Aid Highway guidelines adopted by the Public Works Commission. These funds cannot be used for routine maintenance or repairs such as pothole patching and crack sealing. Instead, the funding under Chapter 90 must be allocated to resurfacing and related work. For complete descriptions of Chapter 90 and other sources of funding for local road maintenance, see Appendix C.

Data concerning Chapter 90 allocations and spending for 1980 through 1987 was obtained from the MDPW Public Information and State Aid Offices and included detailed information for the fifteen sample communities. This information was verified by the superintendents of highways of each of the fifteen communities.

The data in Table 3 shows that between 1978 and 1987, the MAPC region's communities were allocated approximately $150 million (in constant 1986 dollars) under thirteen different agreements. Table 4 and Figure 4 show that the annual Chapter 90 allotments for the region, in actual dollars, have increased over the past ten years. When adjusted for inflation, the data show that the allotments have remained relatively unchanged, with the region's communities receiving approximately $20 million each year from state funds. However, Chapter 90 allocations as a percentage of total highway expenditures have risen dramatically from almost 44 percent in 1982 to over 67 percent in 1985 as shown in Figure 5.

Information in Table 5 for six communities indicates that only an estimated 6 percent, or about $7 million, of the state funds allocated between 1978 and 1986 have not been spent to date and remain available for future projects.

See Appendix B for complete data on past Chapter 90 allocations.

TABLE 3

CHAPTER 90 ALLOCATIONS

(1986 dollars in parentheses)

Fiscal Year	Agreement No.	Total State Allotment	Allotments to MAPC Communities (estimated)
78-79	Chptr 356 ('77 Bond)	$27,000,000 (41,815,957)	$9,904,807 (15,339,963)
78	Chptr ('77 Budget)	N.A.	N.A.
79	Chptr ('78 Budget)	N.A.	N.A.
80-81	Chptr 480 ('79 Bond)	20,000,000 (27,567,447)	7,638,202 (10,528,286)
80	Chptr ('79 Budget)	N.A.	N.A.
81	Chptr 329 ('80 Budget)	18,081,000 (24,196,457)	7,566,297 (10,125,412)
81	Chptr 570 ('80 Special)	10,000,000 (13,382,256)	4,183,771 (5,598,829)
82-83	Chptr 732 ('81 Bond)	25,000,000 (30,668,662)	10,646,402 (13,060,436)
82	Chptr 351 ('81 Budget)	20,925,000 (26,417,330)	8,911,033 (11,249,974)
83	Chptr 191 ('82 Budget)	21,000,000 (25,011,336)	8,882,950 (10,579,736)
84-85	Chptr 637 ('83 Bond)	40,000,000 (43,672,000)	17,248,776 (18,832,214)
84	Chptr 289 ('83 Budget)	20,706,000 (23,265,262)	9,042,234 (10,159,854)
85	Chptr 234 ('84 Budget)	18,300,000 (19,398,000)	7,917,542 (8,392,595)
86-87	Chptr 811 ('85 Bond)	60,000,000 (58,301,887)	24,819,056 (24,116,630)
86	Chptr 140 ('85 Budget)	18,300,000 (18,300,000)	7,859,470 (7,859,470)
87	Chptr 206 ('86 Budget)	19,650,000 (18,537,736)	8,394,665 (7,919,495)
	TOTAL	$318,962,000 (370,534,330)	$133,015,205 (153,762,894)

Source (total state allotments): State Aid Office, MDPW

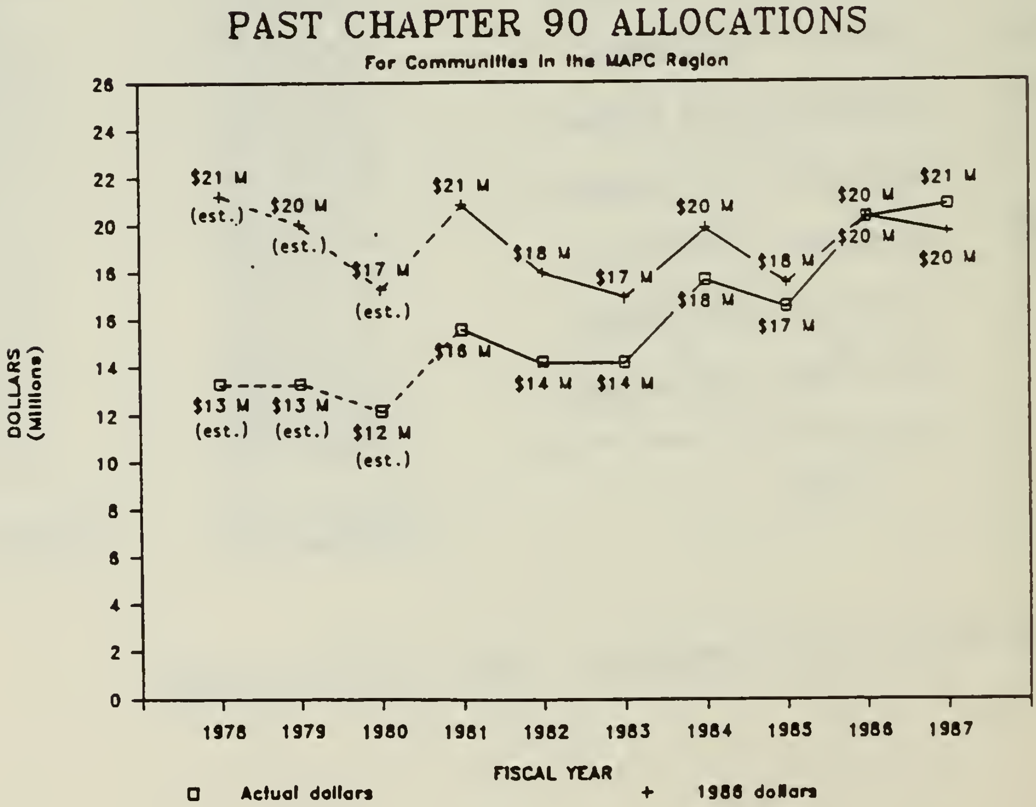
TABLE 4

CHAPTER 90 ALLOCATIONS BY YEAR FOR MAPC COMMUNITIES
(estimated)

Year	Actual Dollars	1986 Dollars
1978	N.A.	N.A.
1979	N.A.	N.A.
1980	N.A.	N.A.
1981	$15,569,169	$20,835,060
1982	14,234,234	17,970,392
1983	14,206,151	16,919,753
1984	17,666,622	19,850,216
1985	16,541,930	17,534,446
1986	20,268,998	20,268,998
1987	20,804,193	19,626,597

Derived from data provided by State Aid Office, MDPW

FIGURE 4



PAST CHAPTER 90 ALLOCATIONS

For Communities in the MAPC Region

FIGURE 5

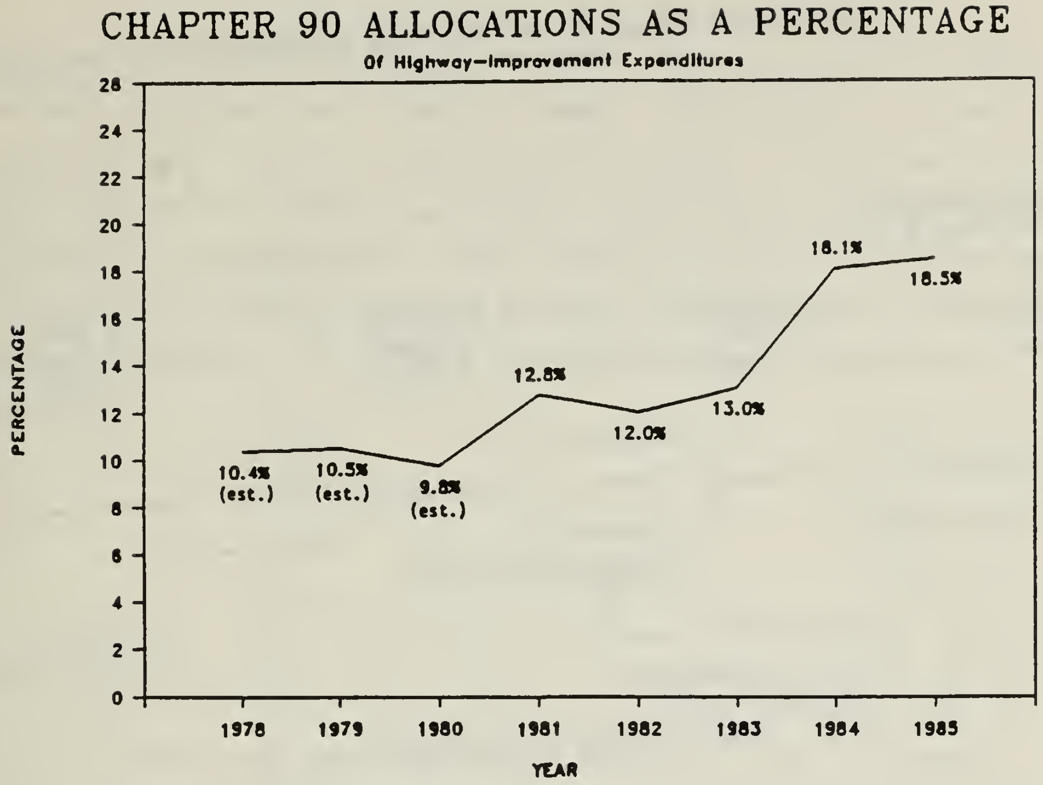


TABLE 5

PERCENTAGE OF CHAPTER 90 FUNDS NOT SPENT TO DATE
(in actual dollars)

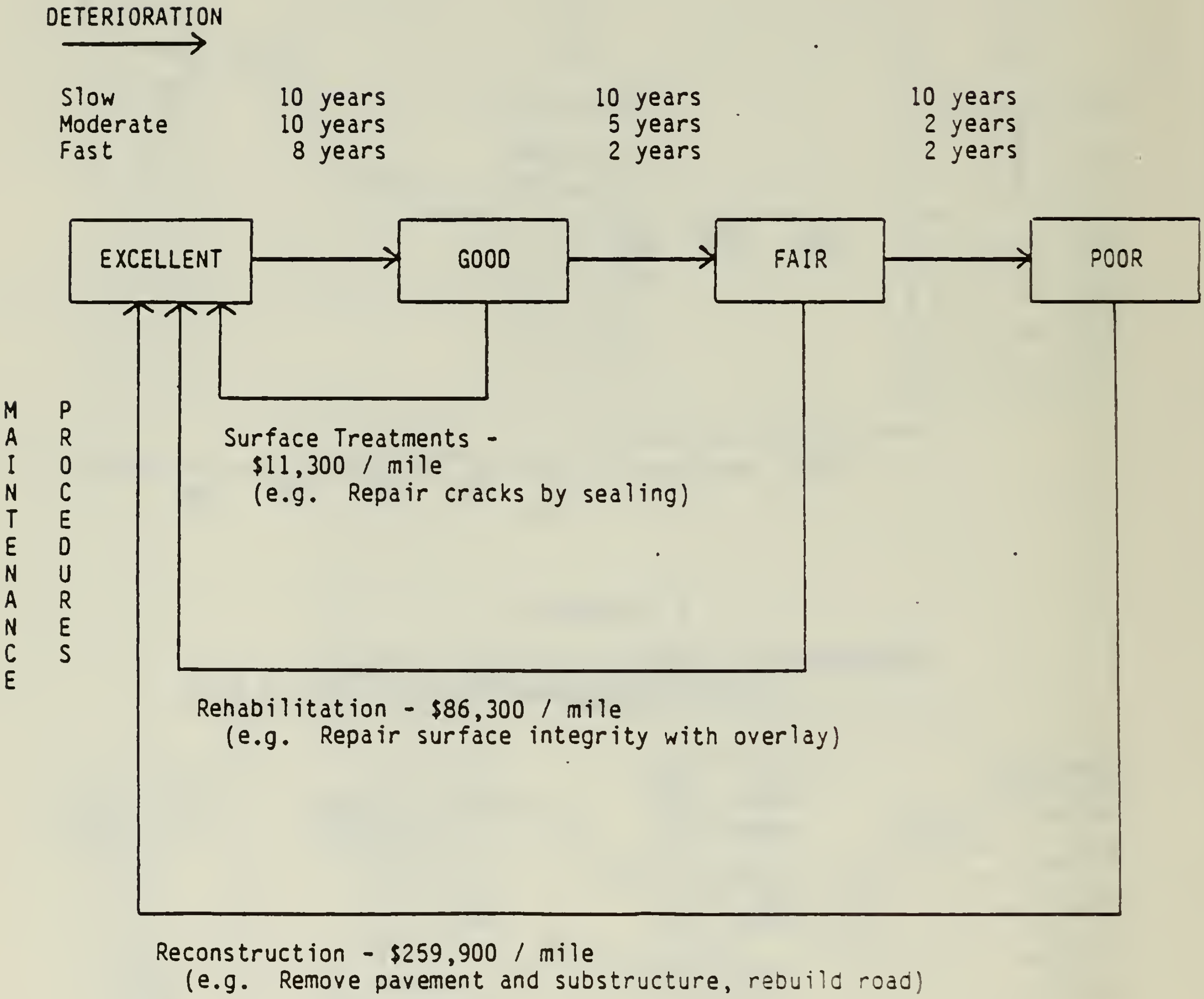
Community	Allocations 1978 - 1986[1]	Total Not Spent to Date[2]	Percentage Not Spent
Belmont	$826,638	$13,664	1.65%
Bolton	364,592	714	0.20%
Brookline	1,511,338	74,060	4.90%
Hingham	794,427	2,057	0.26%
Holliston	590,017	48,312	8.19%
Stow	323,231	62,886	19.46%
			mean 5.78%

[1] Data from State Aid Office, MDPW

[2] Based on surveys of the local highway superintendents.

FIGURE 6

A SIMPLISTIC MODEL OF PAVEMENT MAINTENANCE AND CONDITIONS


DETERIORATION
Slow
Moderate
Fast
10 years
10 years
8 years
10 years
5 years
2 years
10 years
2 years
2 years
EXCELLENT
GOOD
FAIR
POOR
MAINTENANCE PROCEDURES
Surface Treatments - $11,300 / mile
(e.g. Repair cracks by sealing)
Rehabilitation - $86,300 / mile
(e.g. Repair surface integrity with overlay)
Reconstruction - $259,900 / mile
(e.g. Remove pavement and substructure, rebuild road)

EXPECTATIONS FOR THE FUTURE

Using these historical trends and data, it is possible to predict future road conditions and financial needs. The predictions can be used to illustrate the inherent delayed cost of deferred maintenance and to present solutions to correct past shortcomings and reduce the maintenance backlog that has accumulated. This is done by applying a simple model that simulates the contest between pavement deterioration and roadway maintenance. Figure 6 illustrates the model and its operating assumptions.

Model Parameters

Road Conditions

It is assumed that roads can be classified by their pavement condition, ranging from excellent to poor. For the purpose of this study, conditions are grouped into four general categories, defined as follows (from Pavement Management: A Manual for Communities, MAPC):

Excellent - new or nearly new pavement with little distress; no maintenance necessary;

Good - pavement distress but few visible signs of surface deterioration; treatable with sealing and patching;

Fair - pavement displaying moderate distress and a riding quality noticeably inferior to new pavements and may be barely tolerable for high speed traffic;

Poor - extensive distress or near complete failure; pavements deteriorating to such an extent that they are in need of extensive resurfacing or complete reconstruction.

Current Road Conditions

Reports from the six communities that have inventoried their streets (Ashland, Belmont, Burlington, Holliston, Medfield, and Wenham) were used to estimate the region's road conditions. Information was also gathered from seven other towns through surveys and interviews with local highway superintendents.

This sample covers about 950 miles, or approximately 10 percent, of the 9,520 miles of locally-maintained streets in the MAPC region. The region's current road conditions, summarized in Table 6, are derived from the sampled road conditions contained in Table 7.

TABLE 6

CURRENT ROAD CONDITIONS

(MAPC Region)

Excellent	2,094.7 miles	(22.02%)
Good	3,244.1 miles	(34.10%)
Fair	2,364.1 miles	(24.85%)
Poor	1,817.5 miles	(19.10%)
TOTAL	9,520.4 miles	

The Road Inventory File at MDPW also includes information on road conditions. However, this data was initially collected over 12 years ago and, in general, has not been updated.

TABLE 7

SAMPLED CURRENT ROAD CONDITIONS

(Locally-Maintained Roads)

Community	exc.	good	fair	poor	TOTAL
Ashland *	5.45	5.45	21.13	21.28	53.31
Belmont *	44.44	24.62	8.97	2.08	80.11
Bolton **	5.59	22.36	25.15	2.80	55.90
Brookline **	24.04	56.08	21.37	5.34	106.83
Burlington *	17.21	56.80	15.28	4.73	94.02
Concord **	33.30	46.60	2.10	15.80	97.80
Hingham **	8.06	18.79	53.70	26.85	107.40
Holliston **	10.52	29.85	11.58	22.25	74.20
Lincoln **	2.11	8.44	21.11	21.11	52.77
Medfield *	3.92	0.91	21.67	39.05	65.55
Reading **	40.27	28.74	8.63	8.63	86.27
Stow **	10.89	22.06	14.31	7.89	55.15
Wenham **	4.21	4.54	12.01	4.40	25.16
TOTAL	210.01	325.24	237.01	182.21	954.47
%	22.02	34.10	24.85	19.10	

* Data derived from community pavement management reports.

** Data derived through interviews with town highway superintendents.

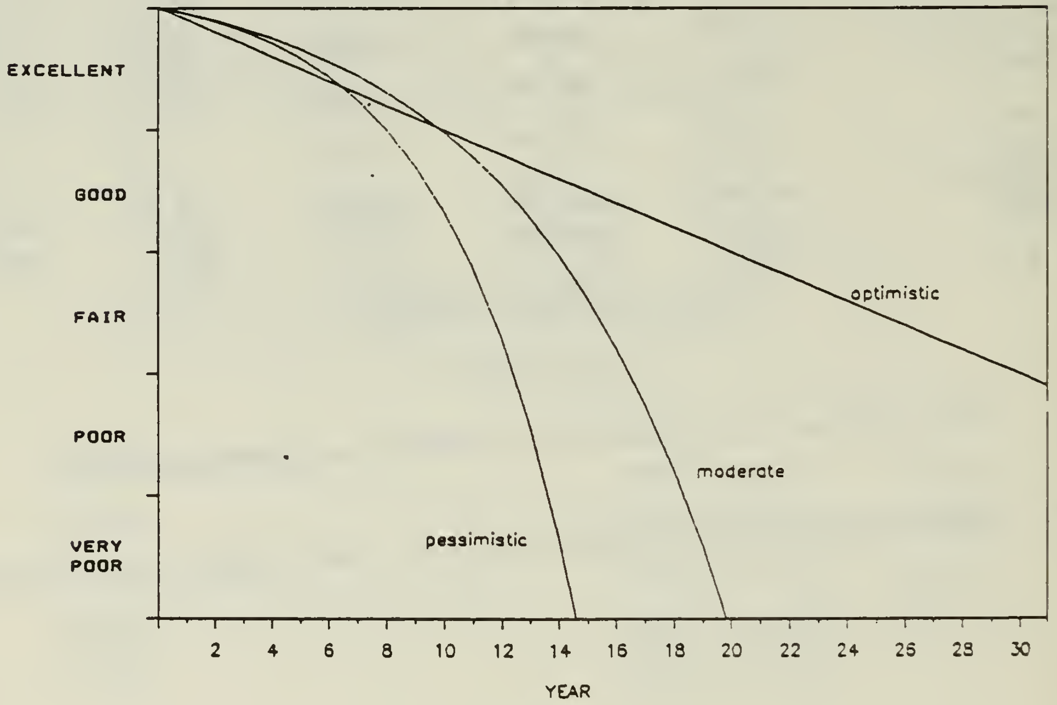
Deterioration Rates

Because funding depends on how quickly roads deteriorate, some assumptions have been made concerning the deterioration rate of pavements. However, deterioration rates are influenced by many factors, such as construction technology and materials, traffic volume and weight, and weather conditions. Therefore, this study uses three different deterioration rates: an optimistic, or slow rate, a middle, or moderate rate, and a pessimistic, or fast rate. The rates are shown in Figure 7 and described in Table 8.

FIGURE 7

DETERIORATION RATES

Used in the Model



It is also assumed that once a road is in poor condition, it stays that way until it is reconstructed.

TABLE 8

DETERIORATION RATES

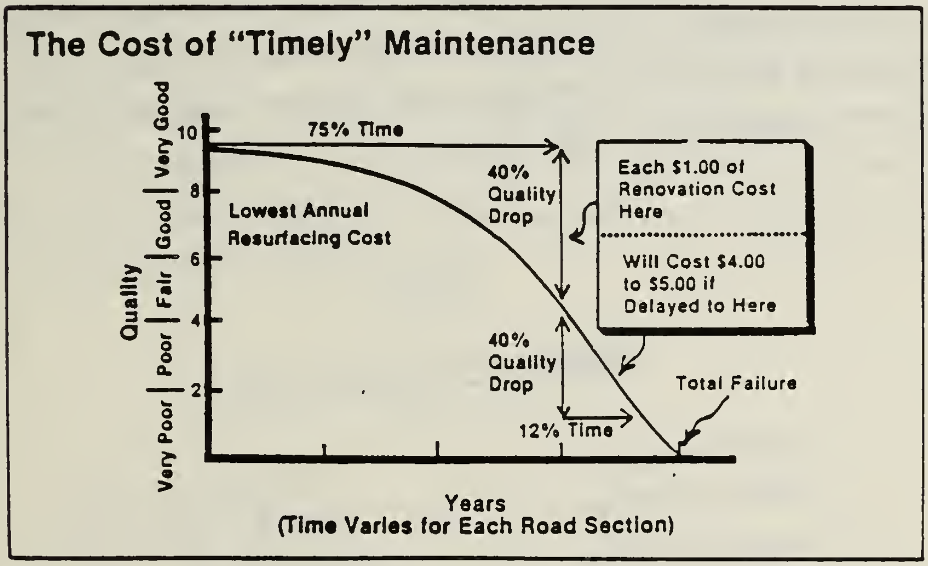
	Scenario 1 (optimistic)	Scenario 2 (moderate)	Scenario 3 (pessimistic)
excellent roads become good in	10 yrs	10 yrs	8 yrs
good roads become fair in	10 yrs	5 yrs	2 yrs
fair roads become poor in	10 yrs	2 yrs	2 yrs

Scenario 1 is based on research by Dr. John Collura (UMass-Amherst) and interviews with local highway superintendents.

Scenario 2 is from the American Public Works Association (The Hole Story) and assumes a pavement lifetime of 20 years (see Figure 8 below).

Scenario 3 is used by Vanasse/Hangen consultants and is based on a curve derived by the Washington Department of Transportation.

FIGURE 8



Source: American Public Works Association, The Hole Story

It is further assumed that surface treatments restore a good road to excellent condition, rehabilitation restores a fair road to excellent condition, and reconstruction restores a poor road to excellent condition (see Figure 6). Surface treatments include crack filling and sealing, rehabilitation includes resurfacing and overlays, and reconstruction is a complete overhauling of the surface and/or base. Although there are many strategies for repairing roads, it is assumed that they all can be classified in these three categories.

It is also assumed that no work is necessary to keep a road in its current condition, athough it will continue to deteriorate, and that any funds spent will be used to restore the road to excellent condition. Routine maintenance costs such as pothole filling are not included in this analysis.

Road Repair Costs

To estimate road repair costs on a per-mile basis, data was extracted from the local pavement studies of Holliston, Wenham, Burlington, Reading, and West Hartford, Connecticut. Additional information was gathered from the American Public Works Association (APWA), the Federal Highway Administration (FHWA), and The Road Information Program (TRIP).

The average costs (in constant 1986 dollars) associated with each strategy are summarized in Table 9.

TABLE 9

AVERAGE CONSTRUCTION COSTS

Maintenance	$11,300 per mile
Rehabilitation	$86,300 per mile
Reconstruction	$259,900 per mile

It is also assumed that there are no inherent costs associated with leaving roads in poor condition. The model does not consider the costs of poor rideability, unsafe conditions. or impassible roads. It also ignores costs for emergency treatments, road user costs, and liability for suits by injured parties. See Appendix D for further discussion of average costs.

Spending Levels

The study aso considers three levels of maintenance spending on the regional scale. First, the existing regional expenditure of $26 million annually (1986 dollars) is extended over a ten year period. Second, the expressed needs of six regional communities that have developed plans to improve their roads (Ashland, Belmont, Burlington, Holliston, Reading, and Wenham) were extrapolated to the region. Data in Table 10 shows that on the average, these six towns' reports recommend spending about $12,000 per mile annually on their streets. If these are representative communities, then the MAPC region should spend approximately $113 million annually to improve its roads. Finally, the spending level the region needs to restore all roads to excellent condition over the next decade is derived. This level varies with deterioration rates and road repair strategies. Assuming a moderate rate of deterioration and a realistic repair strategy, this level is approximately $143 million. If this level is maintained for the length of the repair program, annual expenditures after 10 years decrease to about $10 million annually.

TABLE 10

SAMPLED EXPRESSED NEEDS

Information from Community Pavement Reports

Community	Year of Report	Miles	No. Yrs. in Plan	Expressed Need (1986$/yr)
Ashland	1984	53.31	10	$486,539
Belmont	1986	71.90	10	1,214,000
Burlington	1985	94.02	10	475,000
Holliston	1983	71.10	5	1,429,219
Reading	1977	86.27	20	914,903
Wenham	1986	25.16	15	239,314
		406.76		$4,758,975

Anticipated needs per year per mile (1986 dollars) = $11,845

Extrapolating to the region:

Total Miles:	9,520.34
MAPC Region's Annual Needs:	$112,770,000

NOTE: All monetary amounts were adjusted to constant 1986 dollars using an annual inflation rate of 6 percent which was derived from FHWA data. Previously applied inflation was removed from the reports of Ashland and Reading before readjustment with the FHWA rate.

Road Repair Program Strategies

Since all necessary highway improvements cannot be financed or undertaken at the same time, further assumptions need to be made concerning prioritizing highway maintenance. The philosophy of prioritizing repair projects needs to reflect both worst-first and best-first concepts. Clearly, pavements in the poorest condition have high priority; these sections cause unnecessary wear and tear to vehicles, are expensive to maintain, and may be hazardous. Yet the best roads, those which are well built and in good condition, represent an investment which should be protected against normal deterioration.

There are many different ways to split expenditures among surface treatments, rehabilitation, and reconstruction. This study considers three different strategies. In the first, expenditures are divided among the three procedures so that the number of miles repaired is comparable, in percentage, to the number of miles in the corresponding condition the previous year, ignoring those in excellent condition already. The second strategy concentrates spending on surface treatments first and reconstruction last, meaning that roads in good or fair condition are repaired first, allowing other roads to remain in poor condition. The third funding strategy calls for reconstructing roads in poor condition first, allowing the roads in good and fair condition to deteriorate.

The results of the study are based upon a 10-year program. In some instances it may be appropriate to extend or shorten this time span to reflect improved road conditions. Variations in the length of the program are noted in the results.

Results

The forecasts indicate that current funding for locally-maintained roads in the MAPC region is inadequate. In fact, the current annual level of $26 million cannot even maintain the streets as they are now. The results of the model under the best assumptions, including a moderate deterioration rate and the percentage-based repair strategy, are described below for each of three spending levels. The output from the model for these cases is contained in Appendix E. The graphic results under all the assumptions are also included in Appendix E.

Current Spending

If the current level of spending on highway reconstruction and repairs of $26 million per year is continued over the next 10 years, the region's roads will continue to deteriorate until over 67 percent of the roadways are in poor condition. Figure 9 shows that roads in excellent and good condition will decline from over 50 percent to a little more than 25 percent of the total mileage. There will also be fewer roads in fair condition after 10 years because they will deteriorate from a lack of maintenance. The maintenance backlog, or the amount needed to restore all roads to excellent condition, will also continue to increase dramatically, approaching $2 billion after 10 years as shown in Figure 10.

Expressed Needs Level

If the expressed need of the six communities that have completed pavement management studies is applied to the entire region, the outlook is more optimistic. If the region spends $113 million annually, almost five times the current level, there would be a notable improvement in the

FIGURE 9

REGIONAL ROAD CONDITIONS

if $26 M is spent annually

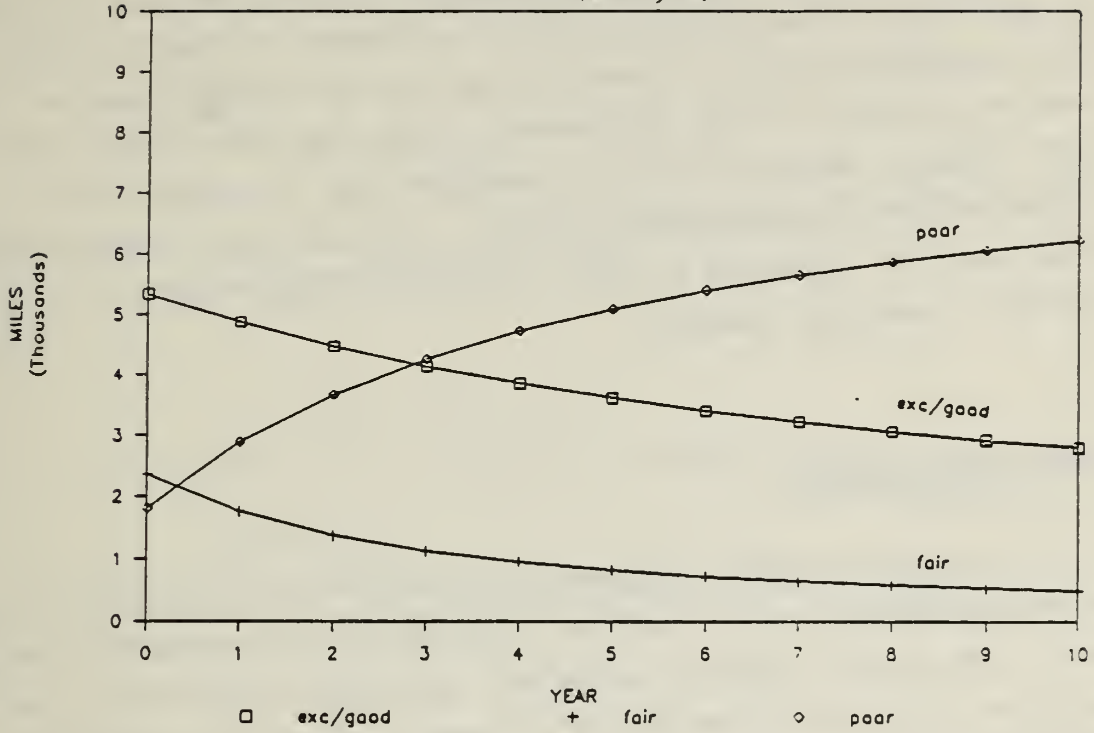
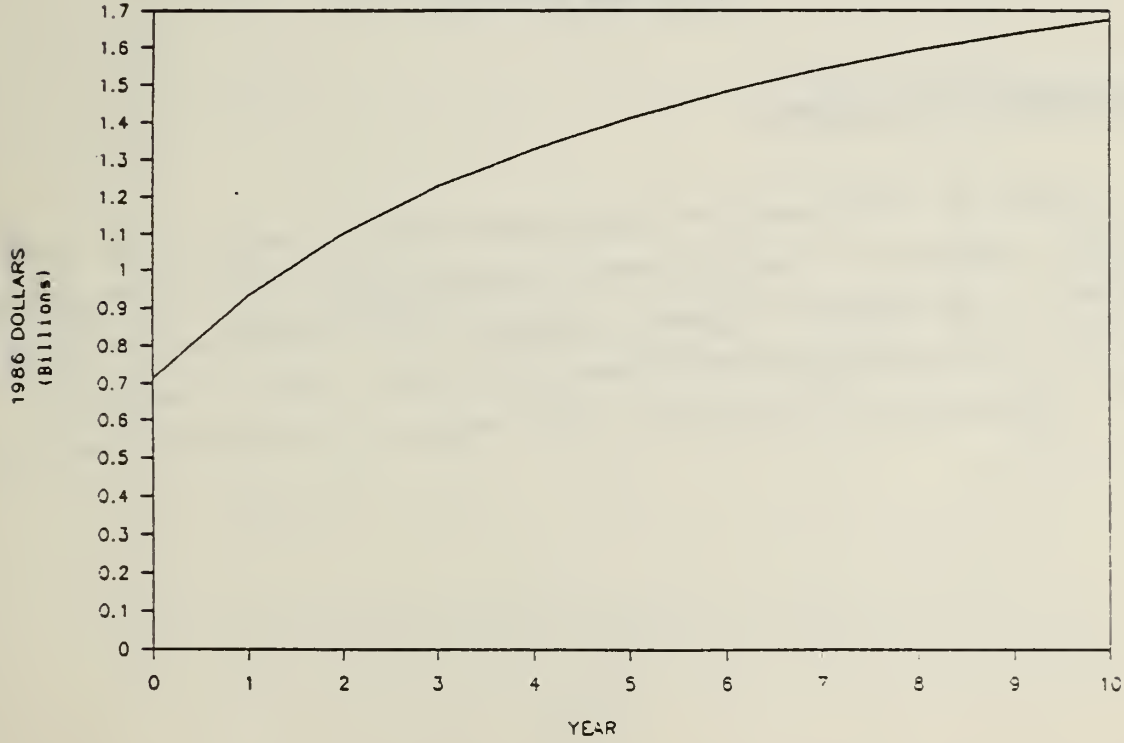


FIGURE 10

REGIONAL ROAD MAINTENANCE BACKLOG

if $26 M is spent annually



region's road conditions, shown in Figure 11. Excellent and good roads would comprise over 75 percent of the system after 10 years of this spending level, while the number of miles in poor condition would remain at about the current amount. This is reflected in Figure 12, which shows the maintenance backlog increasing over the first three years of the program and then falling considerably lower than the current level. In fact, if this spending level was continued over 17 years, all of the road system would be in excellent condition. At that point, annual maintenance needs would be minimized at about $10 million, less than half of the current, inadequate funding.

High Spending Level

If a spending level of approximately $143 million per year on highway reconstruction and repair could be sustained by the region for the next 10 years, the region's locally-maintained roads would continually improve in condition until all of the region's highways would be in excellent condition after 10 years as shown in Figure 13. The annual maintenance need would also fall to the minimum level of approximately $10 million per year after the ten years, as shown in Figure 14.

Long-Range Implications

Figure 15 illustrates the long-range effects of each of the three funding scenarios. After 30 years of spending $26 million per year, 79 percent of the region's highways would be in poor condition, creating a backlog of maintenance needs of over $2 billion. Only 13 percent, or about 1,240 miles of the region's roads would be in excellent condition.

FIGURE 11

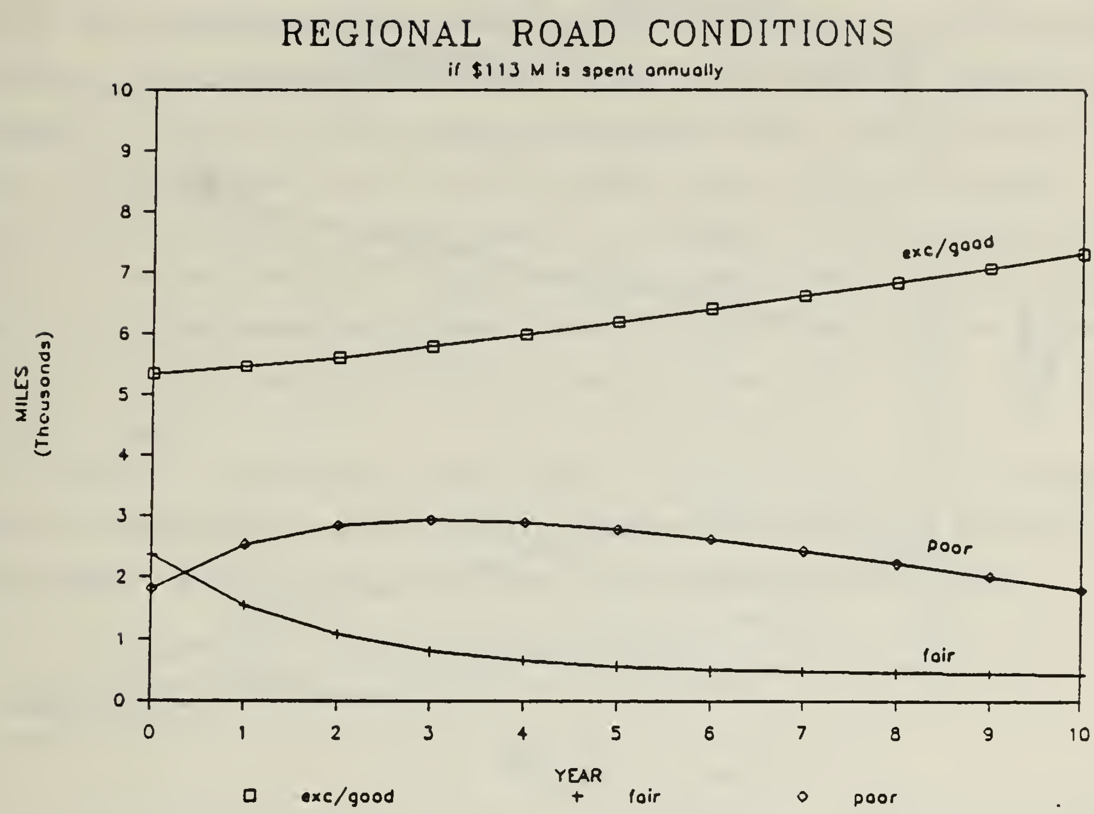


FIGURE 12

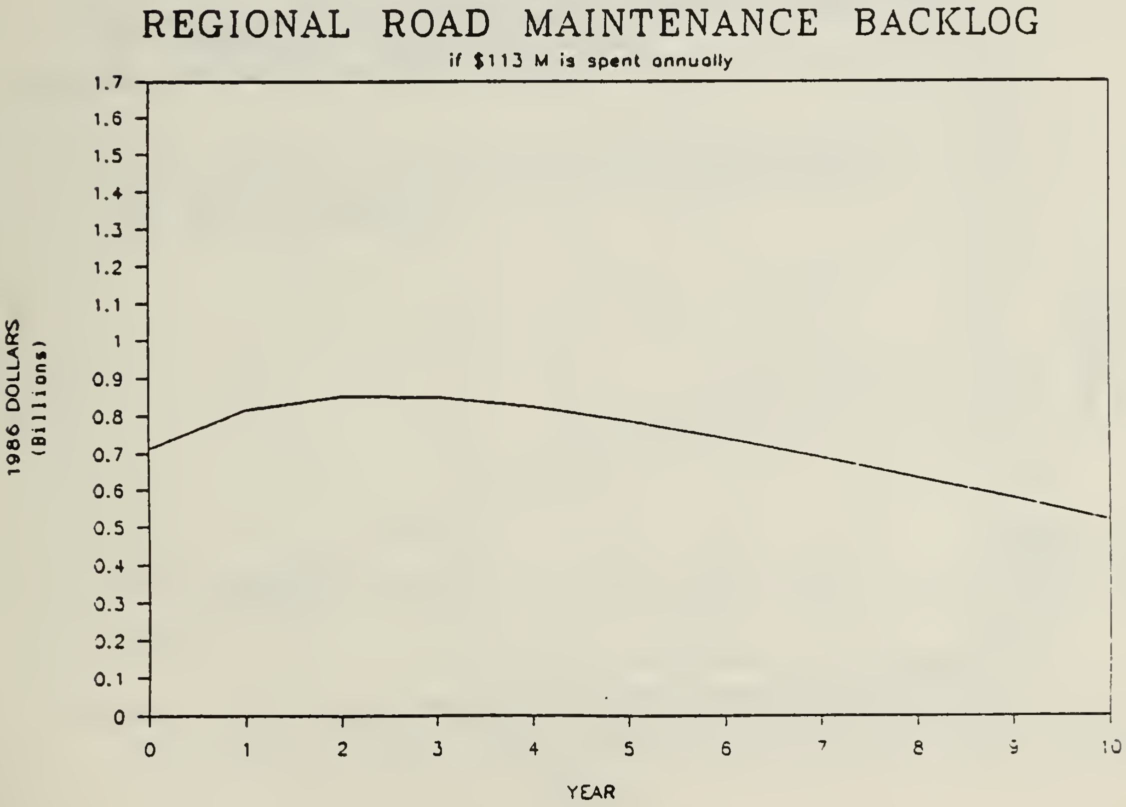


FIGURE 13

REGIONAL ROAD CONDITIONS

if $143 M is spent annually

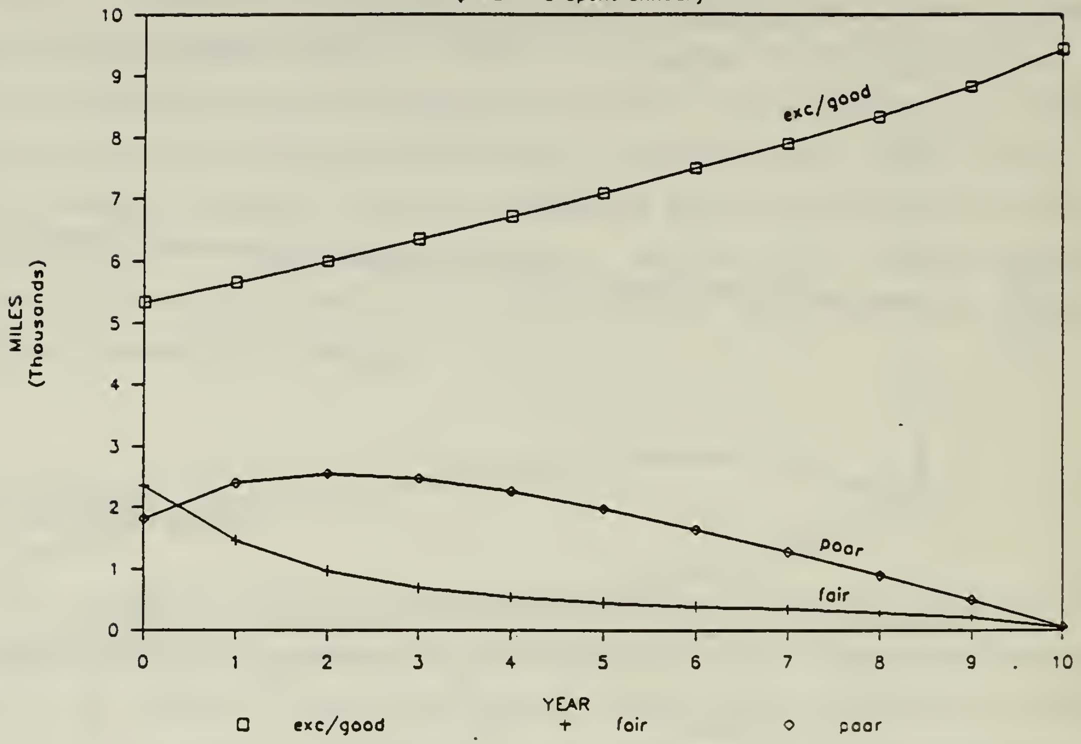
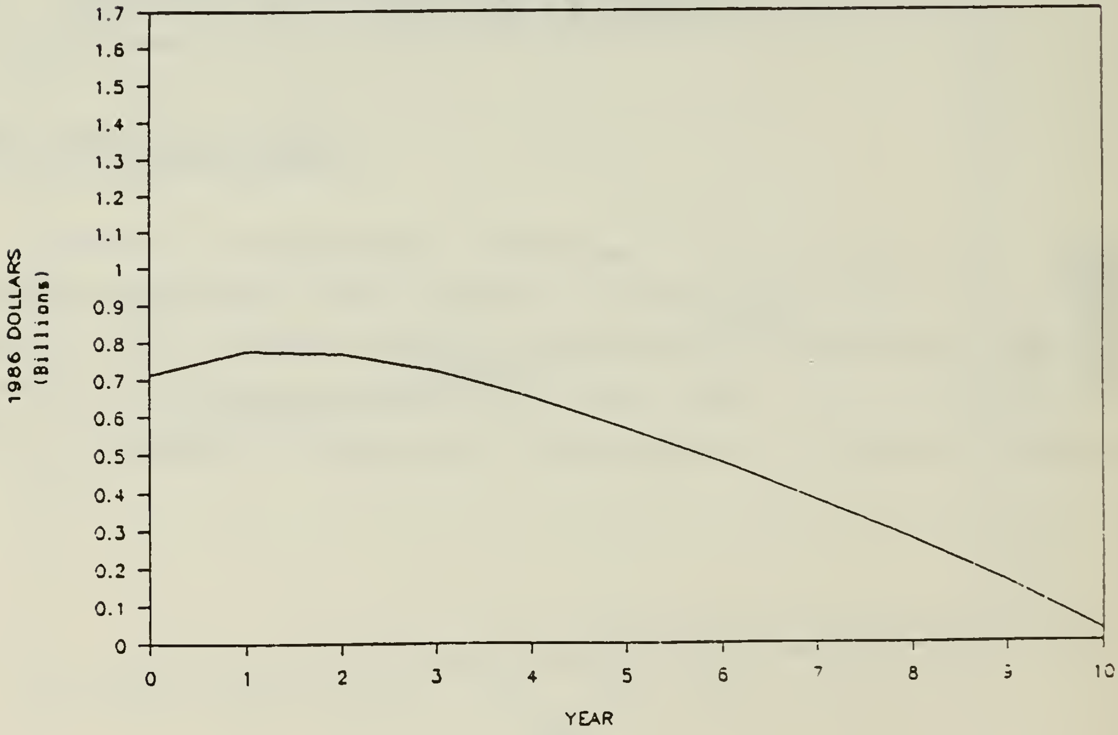


FIGURE 14

REGIONAL ROAD MAINTENANCE BACKLOG

if $143 M is spent annually



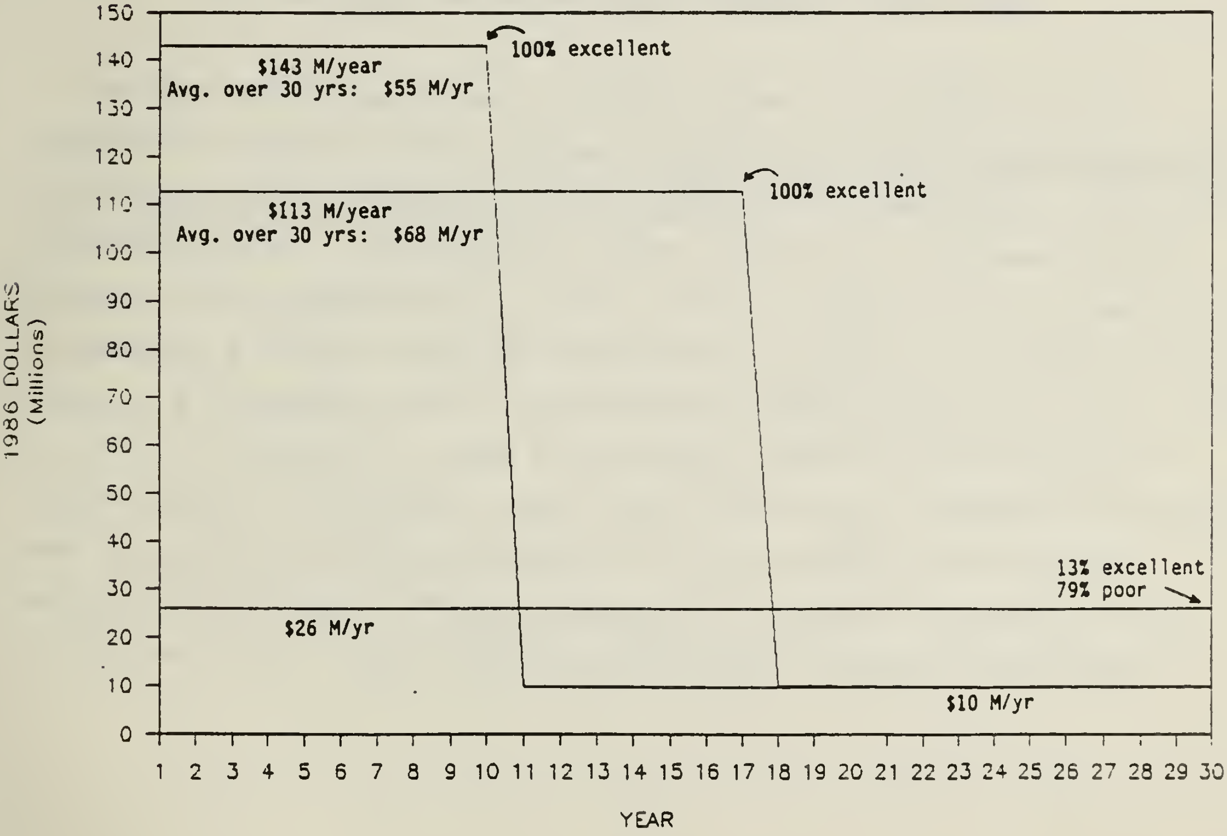
However, if funding increases to $113 million per year, the expressed annual need of the six communities that have completed pavement management studies, all of the region's streets would be in excellent condition after 17 years. After this time, annual maintenance needs would diminish to about $10 million per year. Over 30 years, this scenario averages approximately $68 million per year. At a higher initial spending level of $143 million per year, all roads would be in excellent condition after 10 years, with the annual maintenance need falling to $10 million after that. This high spending scenario averages about $55 million per year over 30 years.

However, it will take a few years to invest enough in the roads to show an improvement overall, simply because of the current condition of the streets, a direct effect of previously deferred maintenance.

FIGURE 15

THREE LONG-RANGE FUNDING SCENARIOS

Anticipated Results



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CONCLUSIONS

The analysis described in this report leads to the following conclusions:

- Revenues currently allocated for highway improvements are inadequate as local governments are increasingly deferring roadway maintenance.

- Fiscal pressures on local jurisdictions have increased because revenue sources are constrained by Proposition 2 1/2.

- Although state aid under Chapter 90 has dramatically increased as a percentage of highway improvement expenditures over the past few years, it has not effectively offset the reduction of local funds for road repair.

- The problem will grow considerably worse over the next decade as the roads age and as more maintenance is deferred.

Similar results have been presented before. In 1982, The Road Information Program (TRIP) prepared An Analysis of the Economic Benefits of a Highway Repair Program in Massachusetts for Construction Industries of Massachusetts. This analysis, which included all state-maintained mileage in the Commonwealth, is very similar to this study in that it also recommended a 10-year road and bridge repair program. The TRIP analysis reported a statewide need for approximately $520 million per year (in 1986 dollars) to restore all roads to excellent condition. Applying this proportionately to the MAPC region, the TRIP report indicated the region's need to spend about $170 million per year to restore its roads to excellent condition, a figure comparable to the MAPC estimate of $143 million per year. (Note that the TRIP report is based on 1982 data.)

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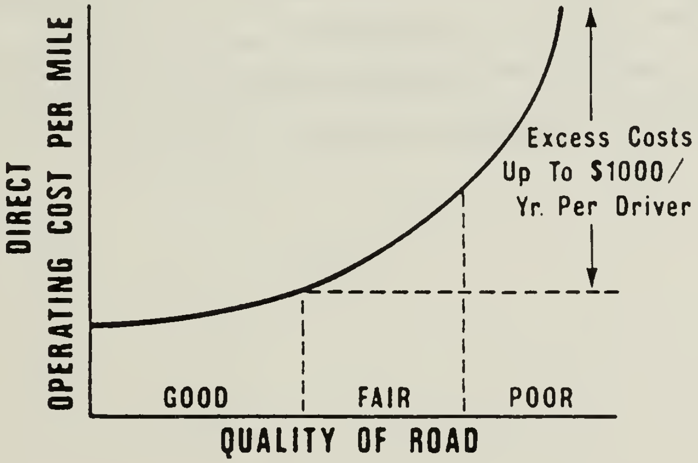
RECOMMENDATIONS

The results of this study confirm the obvious. The region's roads are deteriorating faster than they are being repaired. Regardless of the reason maintenance is being deferred, it is imperative that something be done soon to halt the escalating maintenance backlog. Meanwhile, the roads continue to deteriorate, increasing future repair costs and the overall economic costs of an inadequate regional transportation network.

The TRIP analysis and other similar reports address several other concepts that deserve further comment and analysis. One consideration is the economic costs of allowing poor roads to remain in poor condition. The analysis estimates that automobiles use up to 56 percent more fuel on poor roads than on good pavements, while fair roads increase fuel consumption by 34 percent. Poor roads also increase vehicle maintenance costs. In 1981, the Asphalt Institute estimated that poor pavements can cost the average vehicle owner $310 more in operating expenses. Figure 16 illustrates how operation costs per mile increase as the roads deteriorate into poor condition.

FIGURE 16

ROAD CONDITIONS vs INCREASED USER COST



Source: U.S. Army Corps of Engineers, Pothole Primer

Another item to be addressed is the cost of municipal liability. Under the general laws, a town is liable for up to a maximum of $5,000 or one-fifth of 1 percent of the town's latest state valuation, whichever is less, if a person sustains harm caused by a defect that could have been repaired by reasonable diligence on the town's part.

Another factor in pavement management that deserves comment is the question of utility pavement cuts. Local road systems are often occupied with underground utilities which necessitate frequent pavement openings which accelerate the deterioration process. However, the impact from utility cuts can be diminished with effective control measures. Several communities have reported successful experiences with coordinating utility work with highway repairs. Other communities have implemented utility pavement cut permit systems which place the responsibility for the maintenance and care of pavement patches on the utility for at least a year or two after opening. This helps to reduce the town's share of maintenance costs and encourages quality repairs by the utilities.

The obvious answer is more money, and more money is required if improvements are to be made to the region's highway system. Appendix C contains descriptions of alternative sources of funding for highway maintenance. These alternative sources need to be explored further and their feasibility assessed.

The model upon which this analysis is based is purposely simplified to account for the wide variability in parameters at the regional level. For application at a local level, the model could be refined with the addition of several other factors. Parameters such as road classification, pavement age, and past maintenance procedures, could provide more accurate information on local pavement dynamics and costs.

Such refinements would allow alternative maintenance strategies to be developed in order to make the most effective use of available resources. Local communities should also be encouraged to develop long-term pavement management systems. Also in working closely with the fifteen sample communities, it has become apparent that there are great opportunities to:

- Share information on maintenance treatments and their effectiveness;
- Develop new, more effective maintenance materials and procedures;
- Develop maintenance priorities so that existing budgets are cost-effective; and
- Develop more effective pavement management systems.

Above all, these activities must accompany efforts to make the public and local officials more aware of the mounting problems associated with deferred maintenance so that the hidden perils and high future costs of "relatively harmless" budget cutbacks for highway maintenance may be avoided.